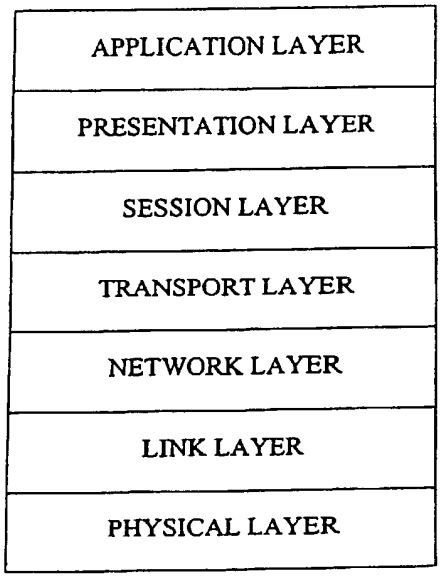
APPLICATION LAYER
PRESENTATION LAYER
SESSION LAYER
TRANSPORT LAYER
NETWORK LAYER
LINK LAYER
PHYSICAL LAYER

FIG. 1

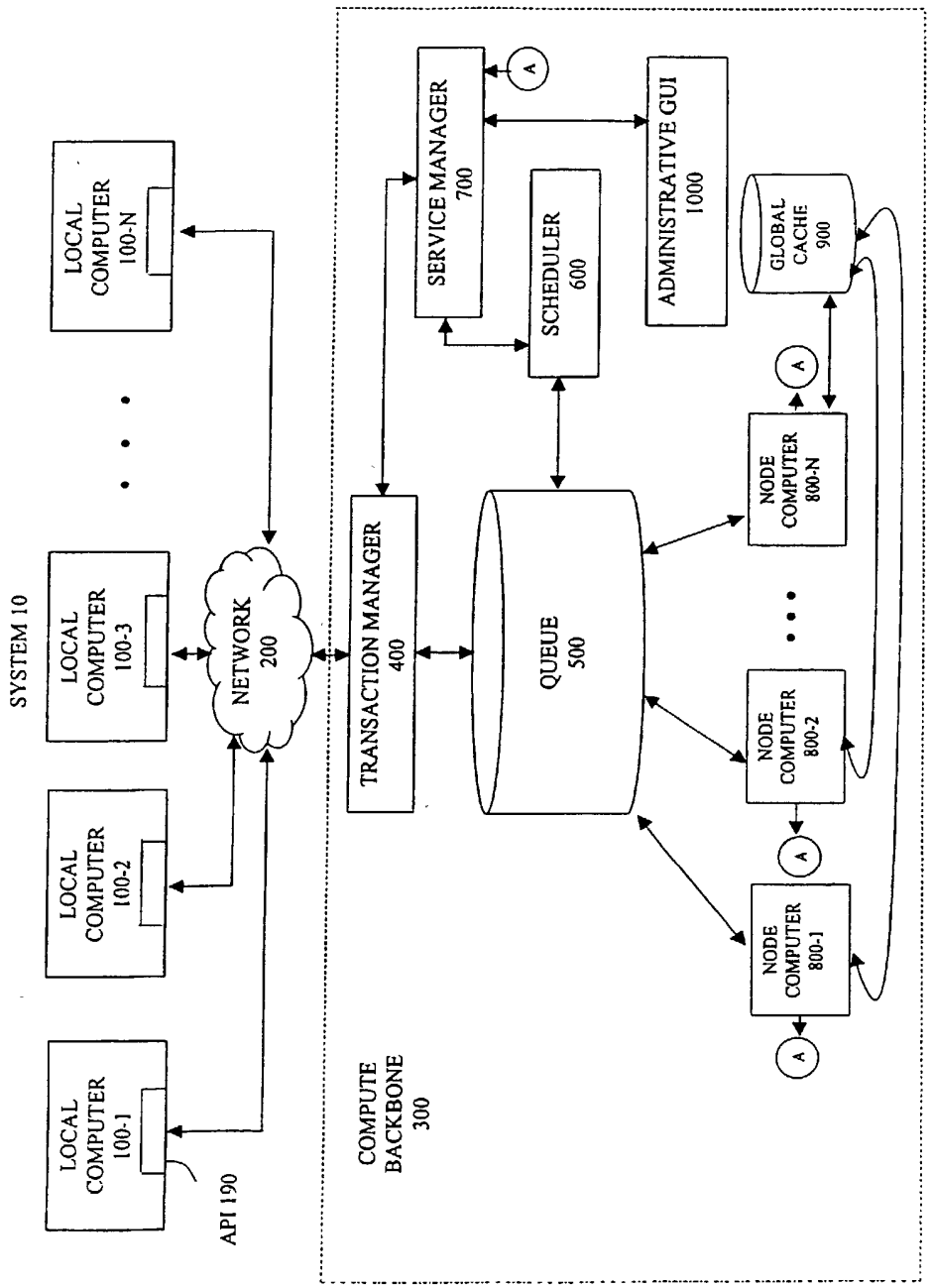
SYSTEM 10
LOCAL COMPUTER 100-1
LOCAL COMPUTER 100-2
LOCAL COMPUTER 100-3
LOCAL COMPUTER 100-N
API 190
NETWORK 200
COMPUTE BACKBONE 300
TRANSACTION MANAGER 400
QUEUE 500
SERVICE MANAGER 700
SCHEDULER 600
ADMINISTRATIVE GUI 1000
GLOBAL CACHE 900
NODE COMPUTER 800-1
NODE COMPUTER 800-2
NODE COMPUTER 800-N
A

FIG. 2

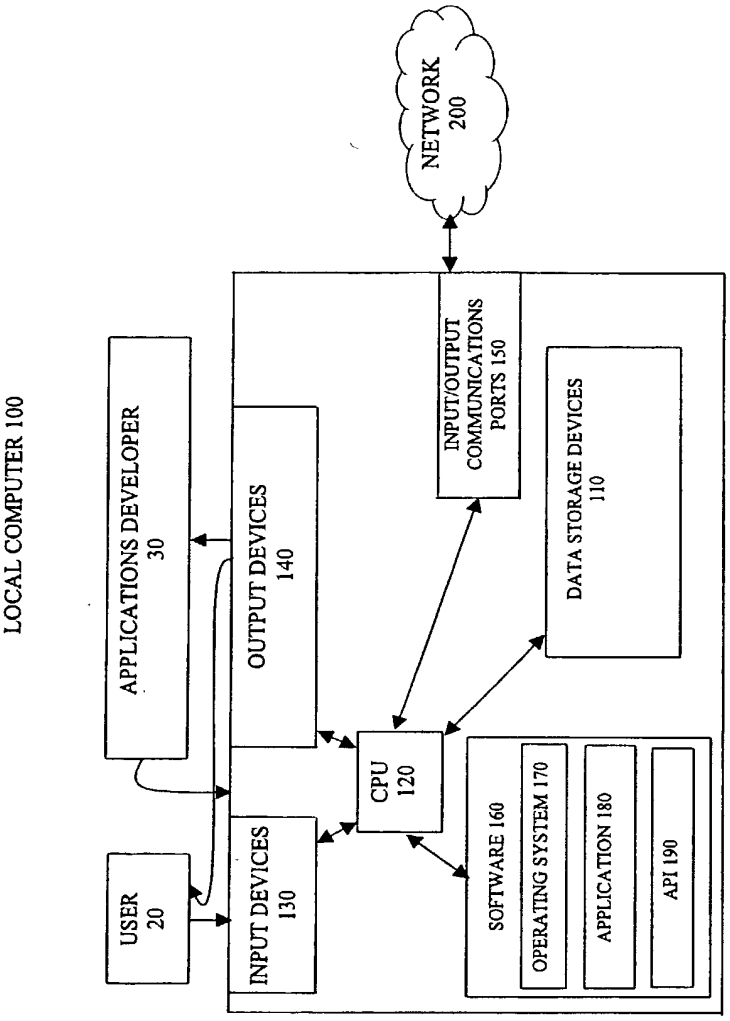
LOCAL COMPUTER 100
NETWORK 200
APPLICATIONS DEVELOPER 30
OUTPUT DEVICES 140
INPUT/OUTPUT COMMUNICATIONS PORTS 150
DATA STORAGE DEVICES 110
CPU 120
USER 20
INPUT DEVICES 130
SOFTWARE 160
OPERATING SYSTEM 170
APPLICATION 180
API 190

FIG. 3

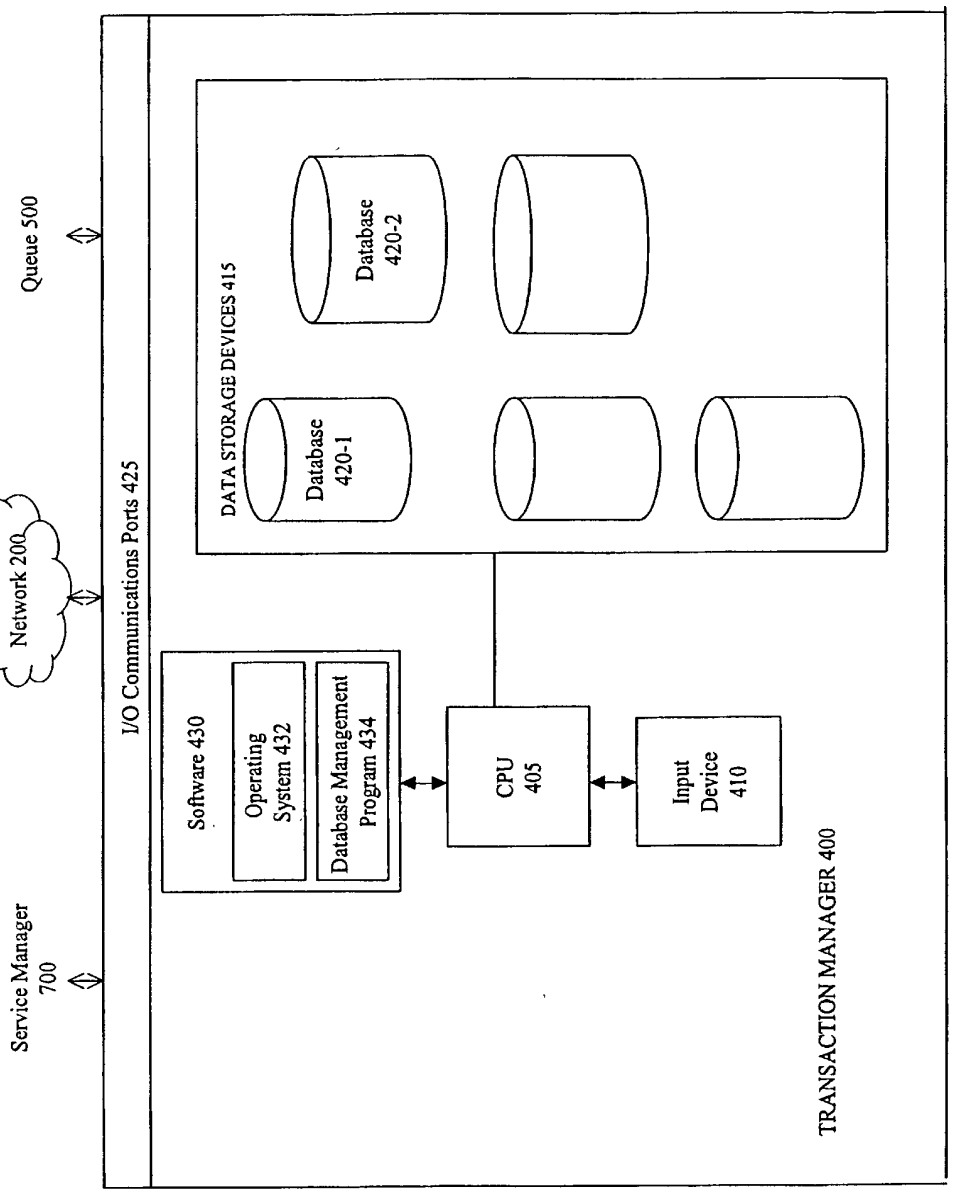
Queue 500
Network 200
Service Manager 700
I/O Communications Ports 425
DATA STORAGE DEVICES 415
Database 420-1
Database 420-2
Software 430
Operating System 432
Database Management Program 434
CPU 405
Input Device 410
TRANSACTION MANAGER 400

FIG. 4

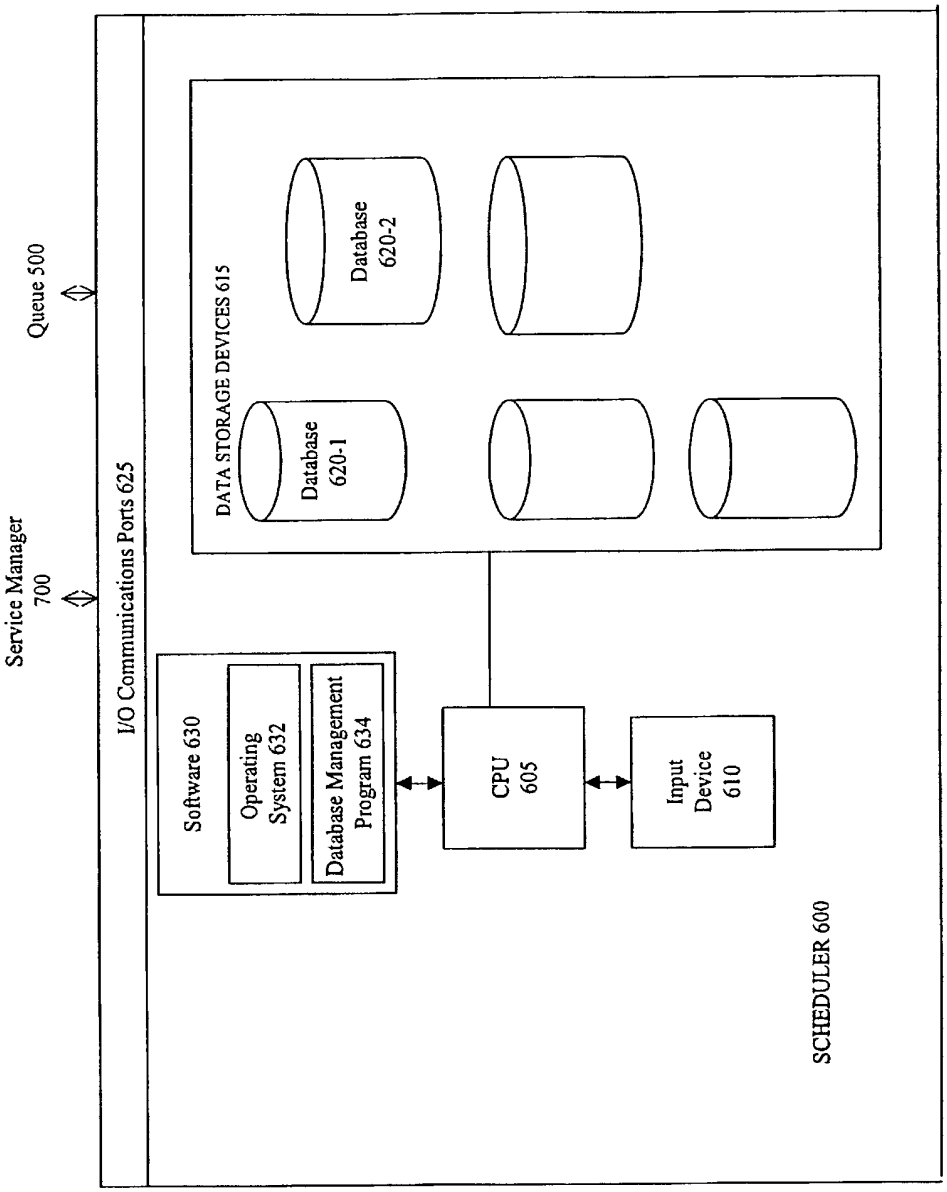
Queue 500
Service Manager 700
I/O Communications Ports 625
DATA STORAGE DEVICES 615
Database 620-2
Database 620-1
Software 630
Operating System 632
Database Management Program 634
CPU 605
Input Device 610
SCHEDULER 600

FIG. 5

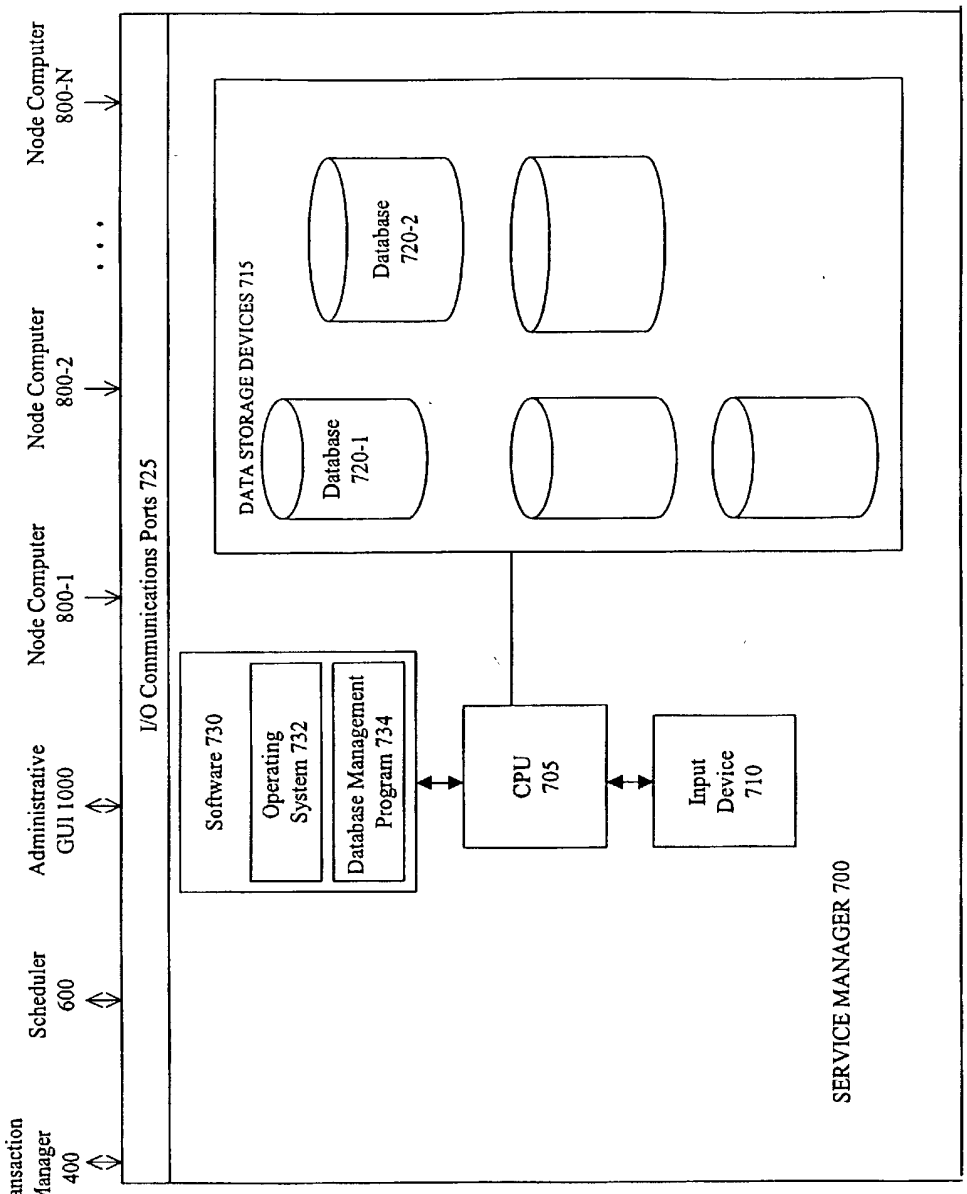
Transaction Manager 400
Scheduler 600
Administrative GUI 1000
Node Computer 800-1
Node Computer 800-2
Node Computer 800-N
I/O Communications Ports 725
DATA STORAGE DEVICES 715
Database 720-1
Database 720-2
Software 730
Operating System 732
Database Management Program 734
CPU 705
Input Device 710
SERVICE MANAGER 700

FIG. 6

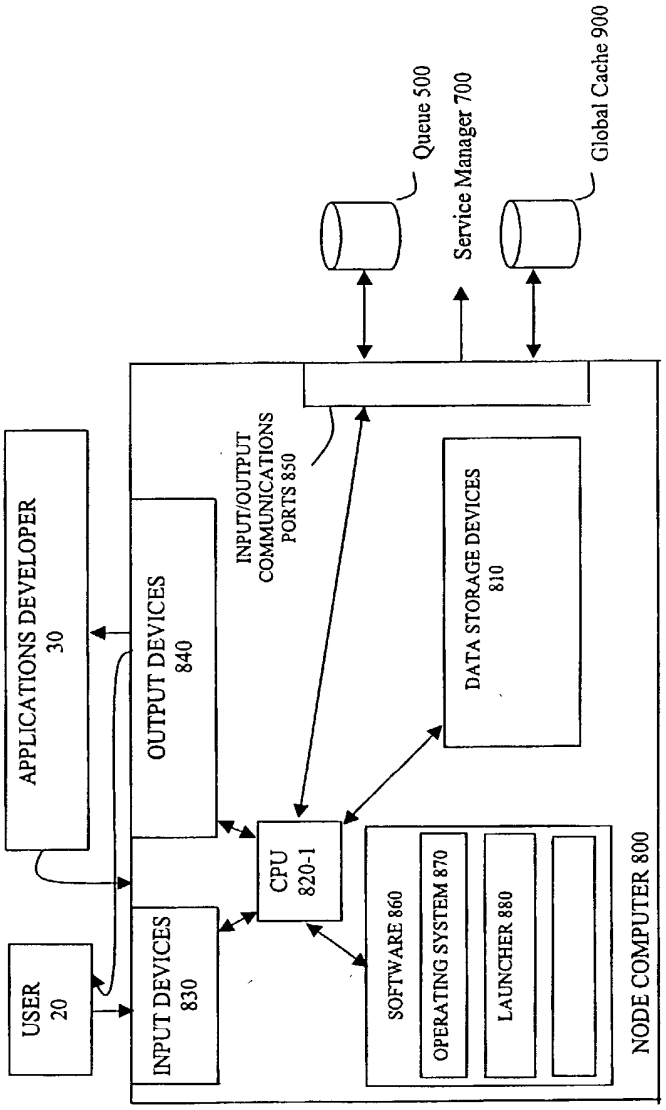
Queue 500
Service Manager 700
Global Cache 900
INPUT/OUTPUT COMMUNICATIONS PORTS 850
APPLICATIONS DEVELOPER 30
OUTPUT DEVICES 840
DATA STORAGE DEVICES 810
CPU 820-1
USER 20
INPUT DEVICES 830
SOFTWARE 860
OPERATING SYSTEM 870
LAUNCHER 880
NODE COMPUTER 800

FIG. 7

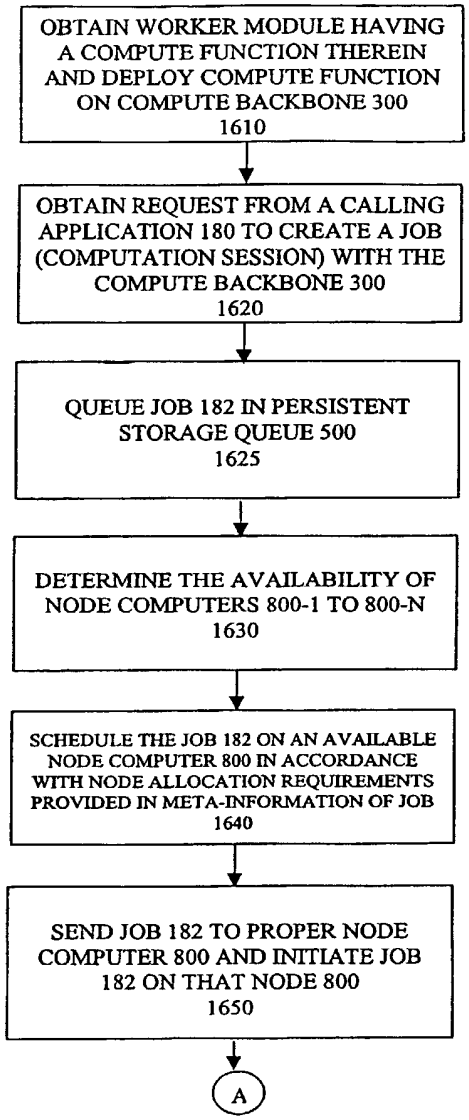
OBTAIN WORKER MODULE HAVING A COMPUTE FUNCTION THEREIN AND DEPLOY COMPUTE FUNCTION ON COMPUTE BACKBONE 300
1610
OBTAIN REQUEST FROM A CALLING APPLICATION 180 TO CREATE A JOB (COMPUTATION SESSION) WITH THE COMPUTE BACKBONE 300
1620
QUEUE JOB 182 IN PERSISTENT STORAGE QUEUE 500
1625
DETERMINE THE AVAILABILITY OF NODE COMPUTERS 800-1 TO 800-N
1630
SCHEDULE THE JOB 182 ON AN AVAILABLE NODE COMPUTER 800 IN ACCORDANCE WITH NODE ALLOCATION REQUIREMENTS PROVIDED IN META-INFORMATION OF JOB
1640
SEND JOB 182 TO PROPER NODE COMPUTER 800 AND INITIATE JOB 182 ON THAT NODE 800
1650
A

FIG. 8a

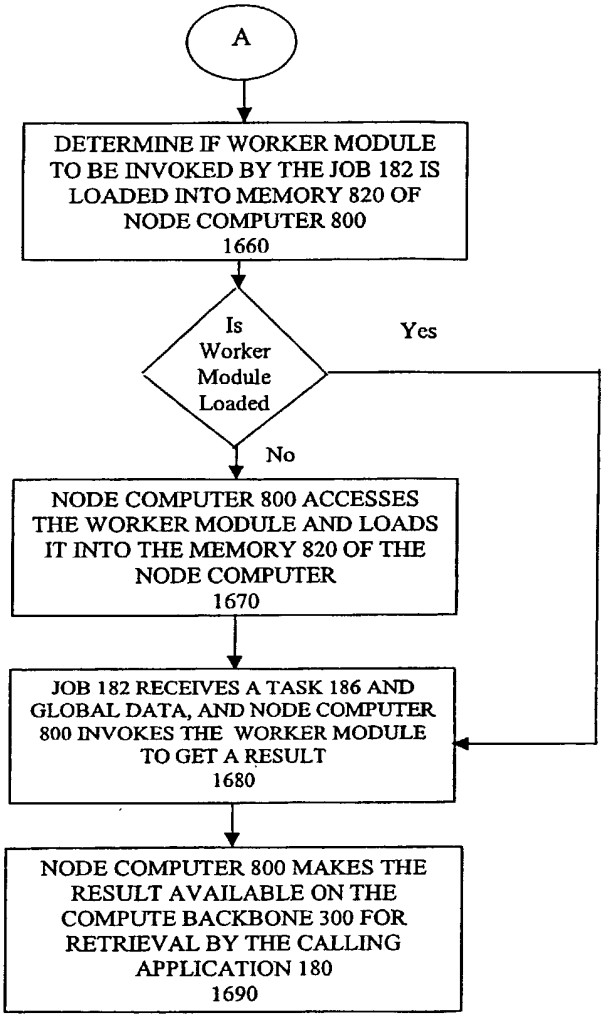
A
DETERMINE IF WORKER MODULE TO BE INVOKED BY THE JOB 182 IS LOADED INTO MEMORY 820 OF NODE COMPUTER 800
1660
Is Worker Module Loaded
Yes
No
NODE COMPUTER 800 ACCESSES THE WORKER MODULE AND LOADS IT INTO THE MEMORY 820 OF THE NODE COMPUTER
1670
JOB 182 RECEIVES A TASK 186 AND GLOBAL DATA, AND NODE COMPUTER 800 INVOKES THE WORKER MODULE TO GET A RESULT
1680
NODE COMPUTER 800 MAKES THE RESULT AVAILABLE ON THE COMPUTE BACKBONE 300 FOR RETRIEVAL BY THE CALLING APPLICATION 180
1690

FIG. 8b

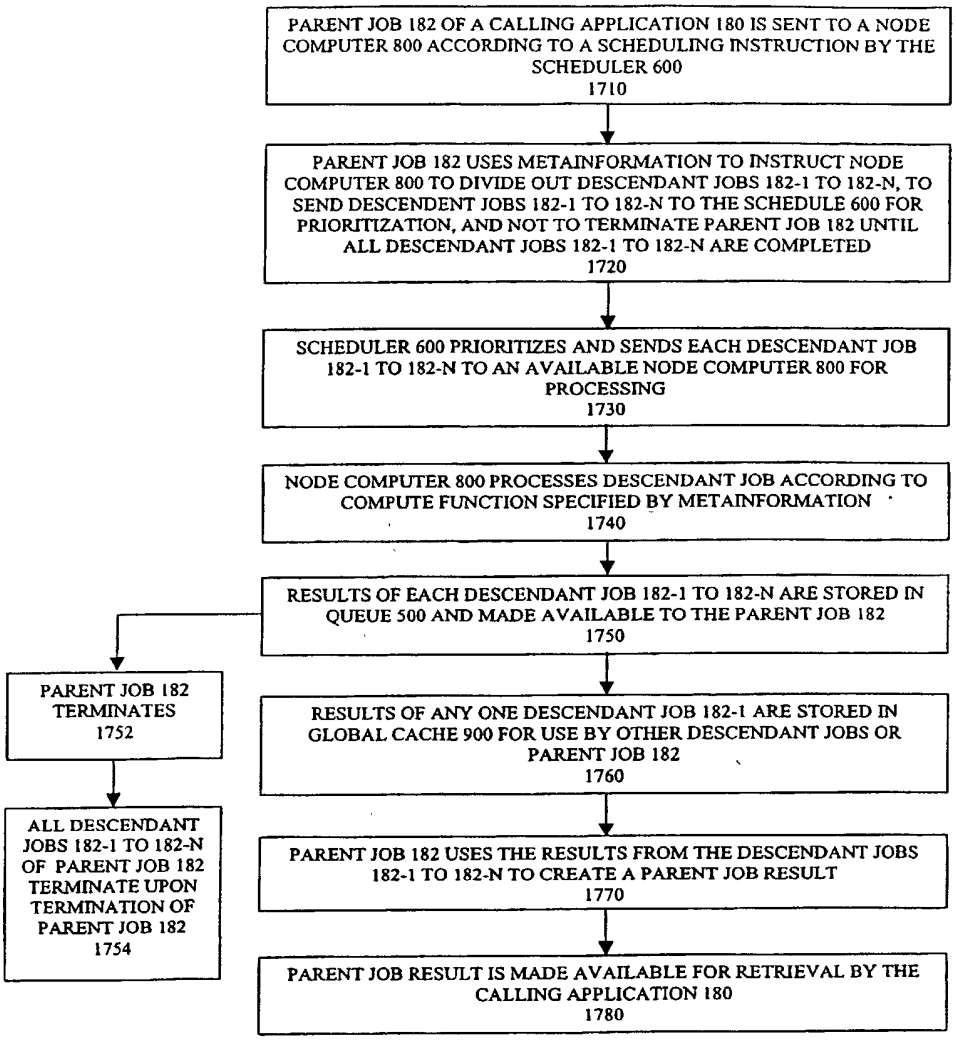
PARENT JOB 182 OF A CALLING APPLICATION 180 IS SENT TO A NODE COMPUTER 800 ACCORDING TO A SCHEDULING INSTRUCTION BY THE SCHEDULER 600
1710
PARENT JOB 182 USES METAINFORMATION TO INSTRUCT NODE COMPUTER 800 TO DIVIDE OUT DESCENDANT JOBS 182-1 TO 182-N, TO SEND DESCENDENT JOBS 182-1 TO 182-N TO THE SCHEDULE 600 FOR PRIORITIZATION, AND NOT TO TERMINATE PARENT JOB 182 UNTIL ALL DESCENDANT JOBS 182-1 TO 182-N ARE COMPLETED
1720
SCHEDULER 600 PRIORITIZES AND SENDS EACH DESCENDANT JOB 182-1 TO 182-N TO AN AVAILABLE NODE COMPUTER 800 FOR PROCESSING
1730
NODE COMPUTER 800 PROCESSES DESCENDANT JOB ACCORDING TO COMPUTE FUNCTION SPECIFIED BY METAINFORMATION
1740
RESULTS OF EACH DESCENDANT JOB 182-1 TO 182-N ARE STORED IN QUEUE 500 AND MADE AVAILABLE TO THE PARENT JOB 182
1750
PARENT JOB 182 TERMINATES
1752
ALL DESCENDANT JOBS 182-1 TO 182-N OF PARENT JOB 182 TERMINATE UPON TERMINATION OF PARENT JOB 182
1754
RESULTS OF ANY ONE DESCENDANT JOB 182-1 ARE STORED IN GLOBAL CACHE 900 FOR USE BY OTHER DESCENDANT JOBS OR PARENT JOB 182
1760
PARENT JOB 182 USES THE RESULTS FROM THE DESCENDANT JOBS 182-1 TO 182-N TO CREATE A PARENT JOB RESULT
1770
PARENT JOB RESULT IS MADE AVAILABLE FOR RETRIEVAL BY THE CALLING APPLICATION 180
1780

FIG. 9

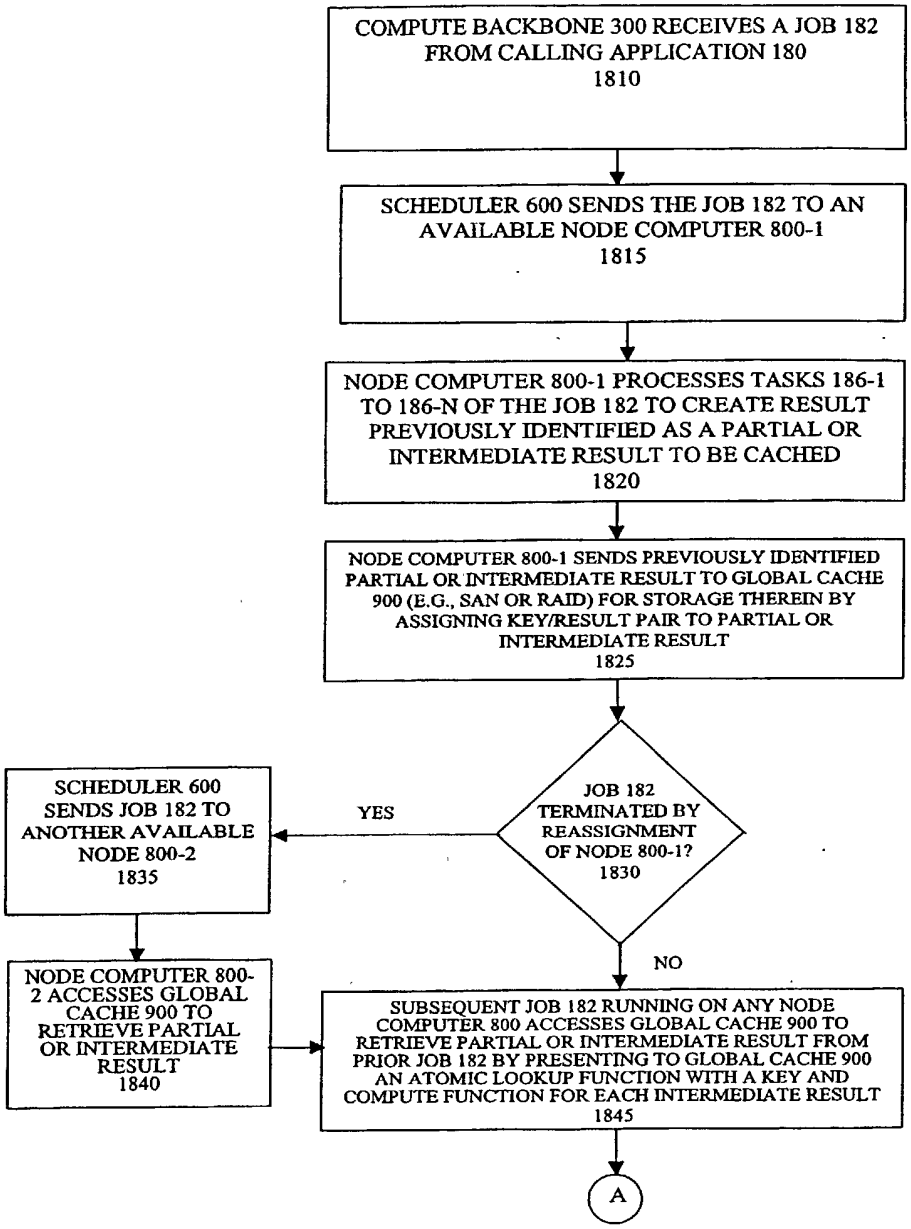
COMPUTE BACKBONE 300 RECEIVES A JOB 182 FROM CALLING APPLICATION 180
1810
SCHEDULER 600 SENDS THE JOB 182 TO AN AVAILABLE NODE COMPUTER 800-1
1815
NODE COMPUTER 800-1 PROCESSES TASKS 186-1 TO 186-N OF THE JOB 182 TO CREATE RESULT PREVIOUSLY IDENTIFIED AS A PARTIAL OR INTERMEDIATE RESULT TO BE CACHED
1820
NODE COMPUTER 800-1 SENDS PREVIOUSLY IDENTIFIED PARTIAL OR INTERMEDIATE RESULT TO GLOBAL CACHE 900 (E.G., SAN OR RAID) FOR STORAGE THEREIN BY ASSIGNING KEY/RESULT PAIR TO PARTIAL OR INTERMEDIATE RESULT
1825
JOB 182 TERMINATED BY REASSIGNMENT OF NODE 800-1?
1830
YES
SCHEDULER 600 SENDS JOB 182 TO ANOTHER AVAILABLE NODE 800-2
1835
NO
NODE COMPUTER 800-2 ACCESSES GLOBAL CACHE 900 TO RETRIEVE PARTIAL OR INTERMEDIATE RESULT
1840
SUBSEQUENT JOB 182 RUNNING ON ANY NODE COMPUTER 800 ACCESSES GLOBAL CACHE 900 TO RETRIEVE PARTIAL OR INTERMEDIATE RESULT FROM PRIOR JOB 182 BY PRESENTING TO GLOBAL CACHE 900 AN ATOMIC LOOKUP FUNCTION WITH A KEY AND COMPUTE FUNCTION FOR EACH INTERMEDIATE RESULT
1845
A

FIG. 10a

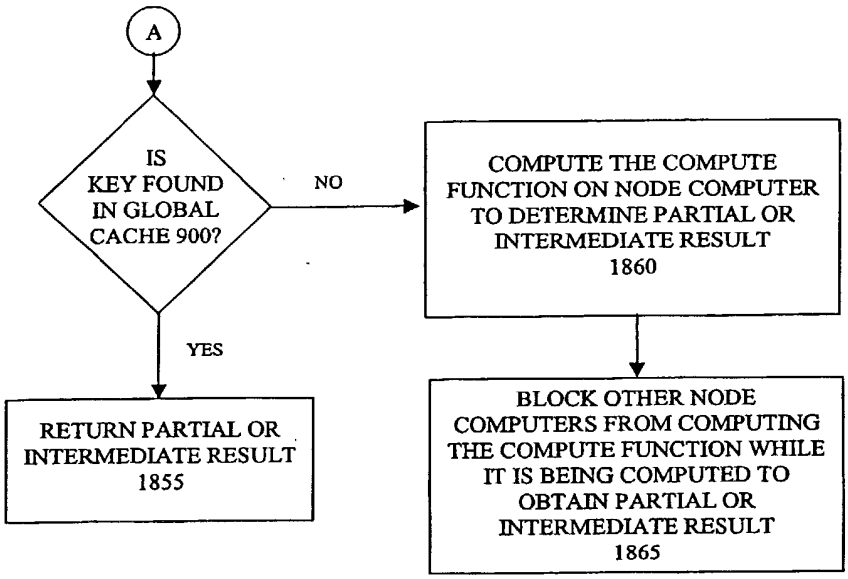
A
IS KEY FOUND IN GLOBAL CACHE 900?
NO
YES
COMPUTE THE COMPUTE FUNCTION ON NODE COMPUTER TO DETERMINE PARTIAL OR INTERMEDIATE RESULT 1860
BLOCK OTHER NODE COMPUTERS FROM COMPUTING THE COMPUTE FUNCTION WHILE IT IS BEING COMPUTED TO OBTAIN PARTIAL OR INTERMEDIATE RESULT 1865
RETURN PARTIAL OR INTERMEDIATE RESULT 1855

FIG. 10b

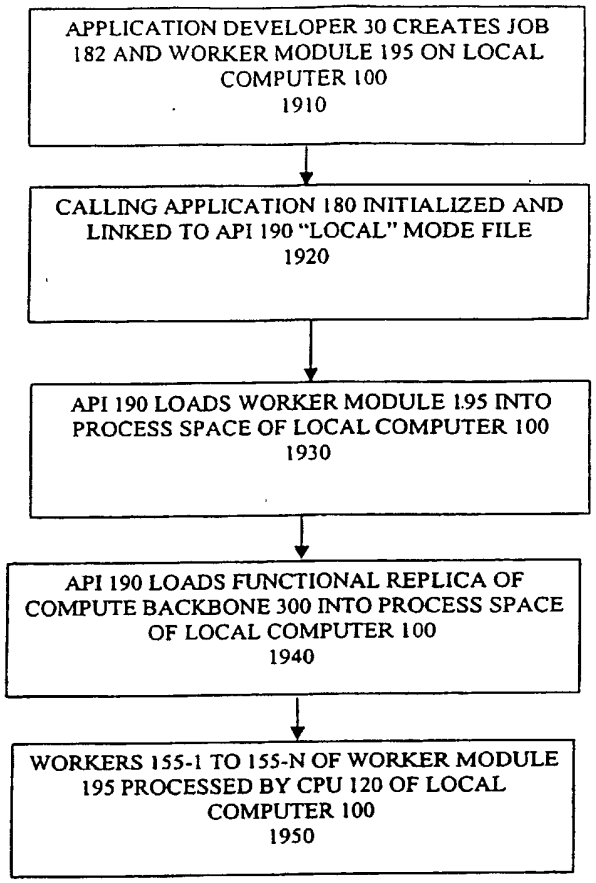
APPLICATION DEVELOPER 30 CREATES JOB 182 AND WORKER MODULE 195 ON LOCAL COMPUTER 100
1910
CALLING APPLICATION 180 INITIALIZED AND LINKED TO API 190 "LOCAL" MODE FILE
1920
API 190 LOADS WORKER MODULE 195 INTO PROCESS SPACE OF LOCAL COMPUTER 100
1930
API 190 LOADS FUNCTIONAL REPLICA OF COMPUTE BACKBONE 300 INTO PROCESS SPACE OF LOCAL COMPUTER 100
1940
WORKERS 155-1 TO 155-N OF WORKER MODULE 195 PROCESSED BY CPU 120 OF LOCAL COMPUTER 100
1950

FIG. 11

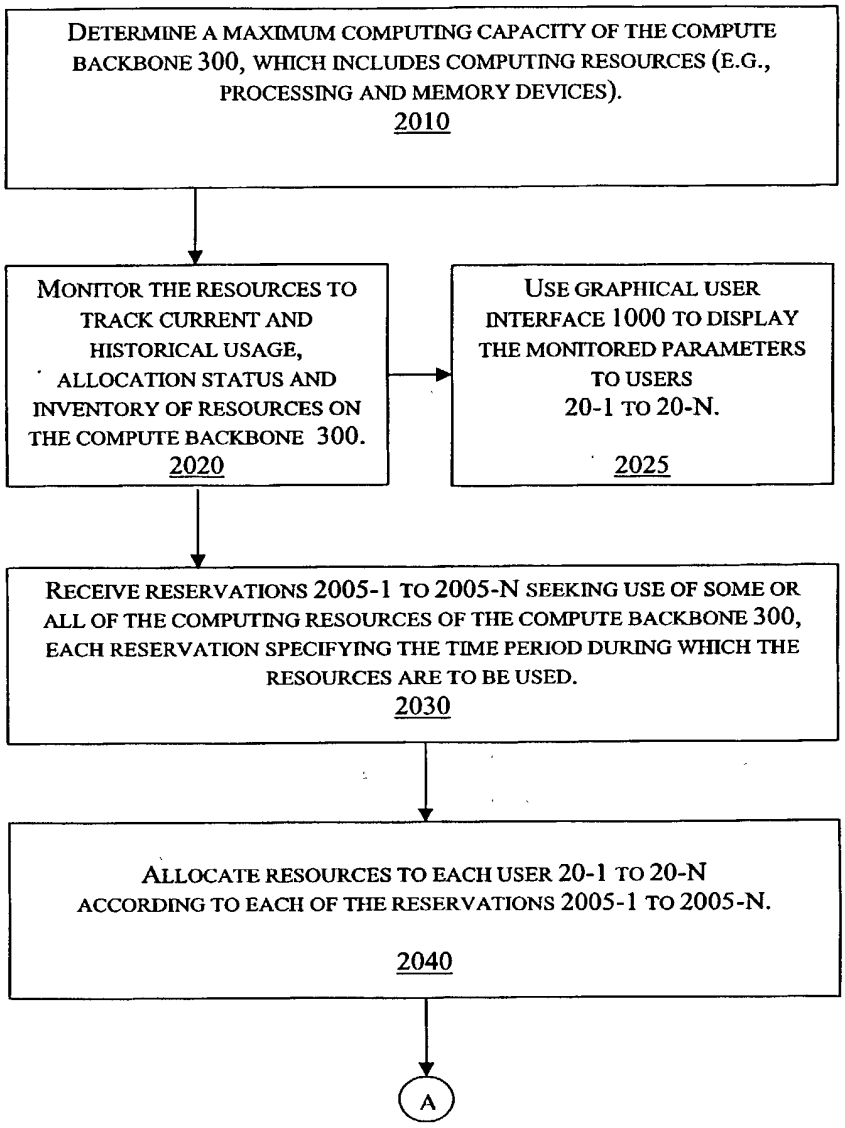
DETERMINE A MAXIMUM COMPUTING CAPACITY OF THE COMPUTE BACKBONE 300, WHICH INCLUDES COMPUTING RESOURCES (E.G., PROCESSING AND MEMORY DEVICES).
2010
MONITOR THE RESOURCES TO TRACK CURRENT AND HISTORICAL USAGE, ALLOCATION STATUS AND INVENTORY OF RESOURCES ON THE COMPUTE BACKBONE 300.
2020
USE GRAPHICAL USER INTERFACE 1000 TO DISPLAY THE MONITORED PARAMETERS TO USERS 20-1 TO 20-N.
2025
RECEIVE RESERVATIONS 2005-1 TO 2005-N SEEKING USE OF SOME OR ALL OF THE COMPUTING RESOURCES OF THE COMPUTE BACKBONE 300, EACH RESERVATION SPECIFYING THE TIME PERIOD DURING WHICH THE RESOURCES ARE TO BE USED.
2030
ALLOCATE RESOURCES TO EACH USER 20-1 TO 20-N ACCORDING TO EACH OF THE RESERVATIONS 2005-1 TO 2005-N.
2040
A

FIG. 12a

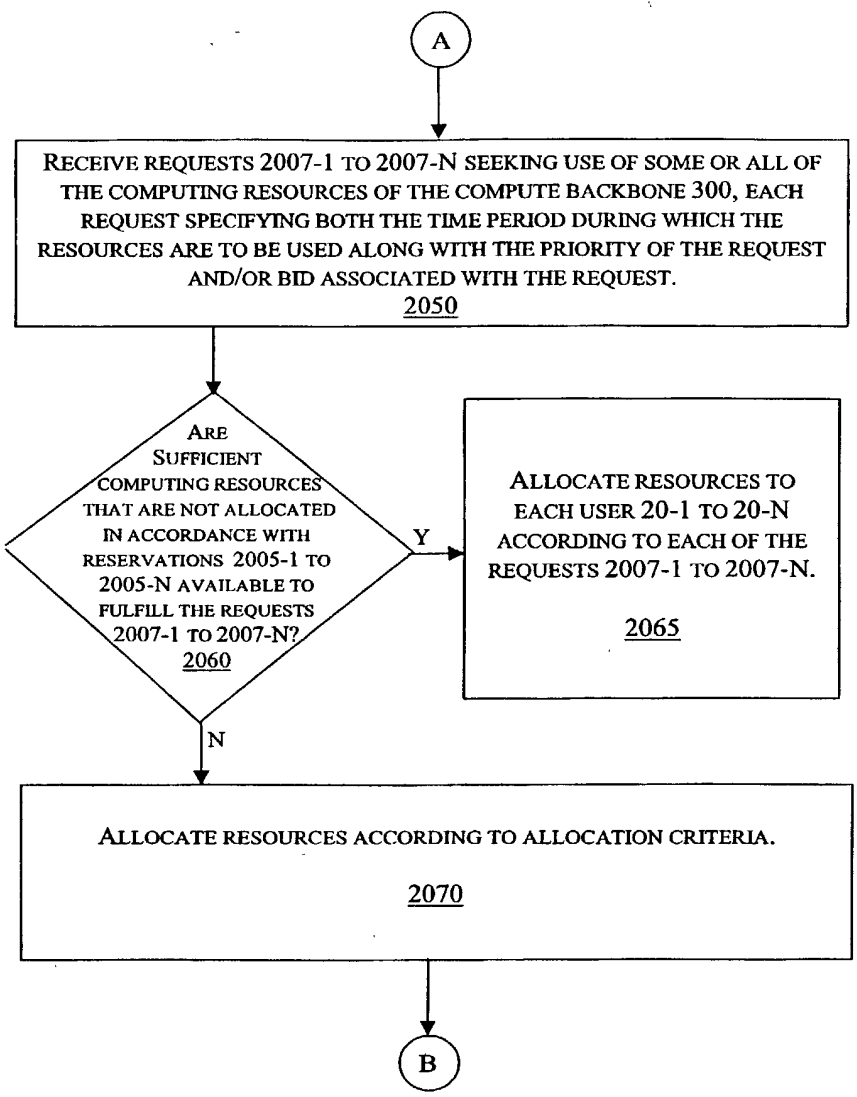
A
RECEIVE REQUESTS 2007-1 TO 2007-N SEEKING USE OF SOME OR ALL OF THE COMPUTING RESOURCES OF THE COMPUTE BACKBONE 300, EACH REQUEST SPECIFYING BOTH THE TIME PERIOD DURING WHICH THE RESOURCES ARE TO BE USED ALONG WITH THE PRIORITY OF THE REQUEST AND/OR BID ASSOCIATED WITH THE REQUEST.
2050
ARE SUFFICIENT COMPUTING RESOURCES THAT ARE NOT ALLOCATED IN ACCORDANCE WITH RESERVATIONS 2005-1 TO 2005-N AVAILABLE TO FULFILL THE REQUESTS 2007-1 TO 2007-N?
2060
Y
ALLOCATE RESOURCES TO EACH USER 20-1 TO 20-N ACCORDING TO EACH OF THE REQUESTS 2007-1 TO 2007-N.
2065
N
ALLOCATE RESOURCES ACCORDING TO ALLOCATION CRITERIA.
2070
B

FIG. 12b

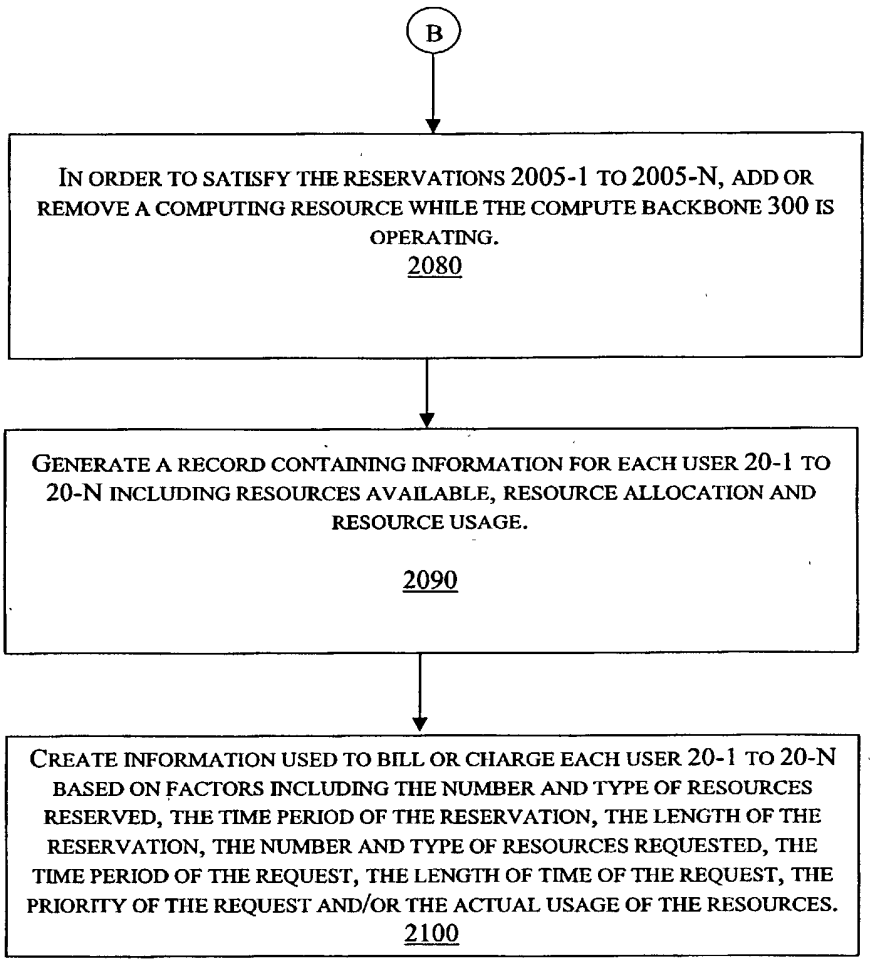
B
IN ORDER TO SATISFY THE RESERVATIONS 2005-1 TO 2005-N, ADD OR REMOVE A COMPUTING RESOURCE WHILE THE COMPUTE BACKBONE 300 IS OPERATING.
2080
GENERATE A RECORD CONTAINING INFORMATION FOR EACH USER 20-1 TO 20-N INCLUDING RESOURCES AVAILABLE, RESOURCE ALLOCATION AND RESOURCE USAGE.
2090
CREATE INFORMATION USED TO BILL OR CHARGE EACH USER 20-1 TO 20-N BASED ON FACTORS INCLUDING THE NUMBER AND TYPE OF RESOURCES RESERVED, THE TIME PERIOD OF THE RESERVATION, THE LENGTH OF THE RESERVATION, THE NUMBER AND TYPE OF RESOURCES REQUESTED, THE TIME PERIOD OF THE REQUEST, THE LENGTH OF TIME OF THE REQUEST, THE PRIORITY OF THE REQUEST AND/OR THE ACTUAL USAGE OF THE RESOURCES.
2100

FIG. 12c

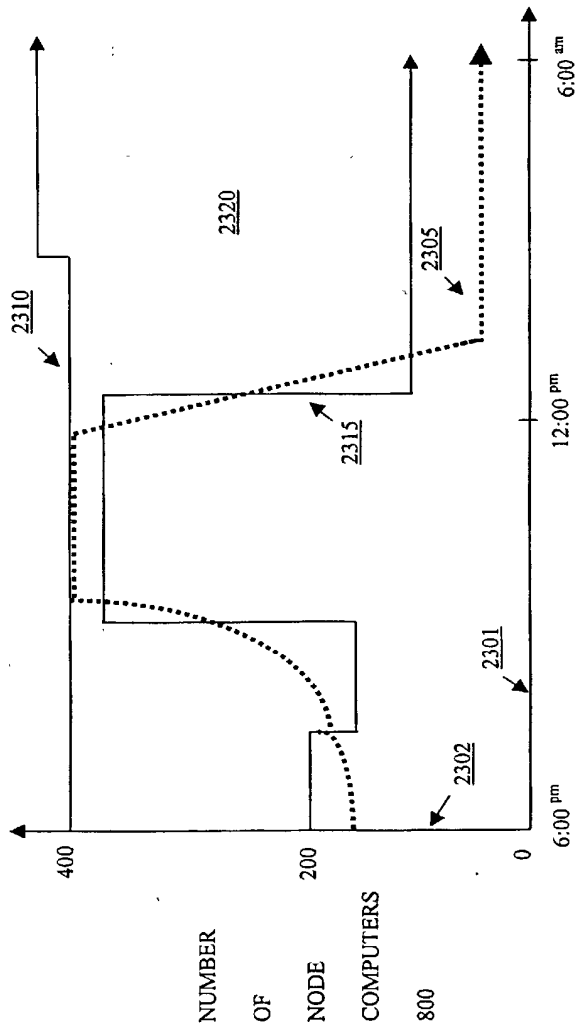
NUMBER OF NODE COMPUTERS
800
400
200
0
6:00 pm
12:00 pm
6:00 am
TIME
2310
2320
2305
2315
2301
2302

FIG. 13

APP_ID=10065546

TYPE/NUMBER OF NODE COMPUTER 800	USER NAMES					
	USER 20-1		USER 20-2		USER 20-3	
	Reserved	In Use	Reserved	In Use	Reserved	In Use
TYPE 1/100	20	10	20	30	40	60
TYPE 2/200	40	20	40	60	80	120
TYPE 3/100	30	33	30	33	40	34

FIG. 14